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HOLOPHANE
REFRACTORS
FOR STREET
LIGHTING

reflectors



OCT 13 1915

HOLOPHANE
REFRACTORS
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LIGHTING

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HOLOPHANE REFRACTORS

GENERAL ELECTRIC COMPANY



FUNDAMENTALS OF STREET LIGHTING

WITHOUT the use of specifically designed and accurately made auxiliaries, the waste of light in street illumination is greater than it is at any other place.

**Comparison of
Interior and
Exterior
Lighting**

Inside lighting offers a much simpler problem because every interior constitutes a sort of natural container and reflector. The walls, ceiling and floor of a room act both as a limit to the path of light, and as a reflector that returns a large portion of it into the area of utility.

In the street, however, there is only one natural surface that is available either as a limit or as a reflector, namely, the ground, and its useful effect is very slight. Lateral limits corresponding to the walls of a room, are of course impossible, if we except such approximations as the walls of buildings along the street.

Top limits, however, are possible, and the first step toward efficiency was made when a reflector was attached to a street lamp.

Light above a horizontal line drawn through a street lamp is absolutely useless for purposes of ground illumination. A reflector, properly designed, will save a large percentage of this top light and send it back to the ground. The result will be rather more illumination than is necessary directly under and near the lamp, but not nearly enough at a point between two lamps spaced at a considerable interval.

**Waste Above
the Horizontal
Line Through
the Lamp**

Holophane Refractors

Limitations of Reflectors

Reflectors for outside use have one drawback—they cannot extend the light rays sufficiently to eliminate dark spots between lamps, unless the spacing is prohibitively close.

It is possible to make a reflector that will give the desired extension, but it is absolutely impracticable because such a reflector would have to be ten or eleven feet in diameter. Even so, the cost would be excessive; it would be impossible to support the reflector by any method now in use, and it would offer too large a target for malicious or accidental damage. Other objections are apparent.

Suitability of Refractors

Happily the principle of refraction offers a perfectly practicable solution. Within the past year or so the whole system of street illumination has been revolutionized by Holophane Refractors now available in two types—bowl and band.

Two Important Definitions

A Reflector bends light by providing an opaque polished or specular surface from which a portion of the light that strikes it is returned at an angle equal to the angle of incidence.

A Refractor bends light by transmission through a transparent medium designed to act as a lens. It is the only auxiliary to a lamp that will give an efficient lateral extension of illumination.

Theoretical reflection of a single ray of light from a naked lamp in a room. The absorption of light varies with the color and texture of the wall coverings, but reflection of a portion of the light takes place as indicated, and results in general diffusion.



Holophane Refractors

A REVOLUTION IN STREET LIGHTING

The principal defect in nearly every existing street lighting installation is that the lamps are not close enough together. Financial limitations have in most cases taken precedence over good practice, and the result is, perhaps, an average spacing of 250 feet between units.

Spacing

Without reflectors the light waste is very heavy, and at this spacing the dark areas are very large.

With reflectors the distribution is more efficient, but by no means adequate.

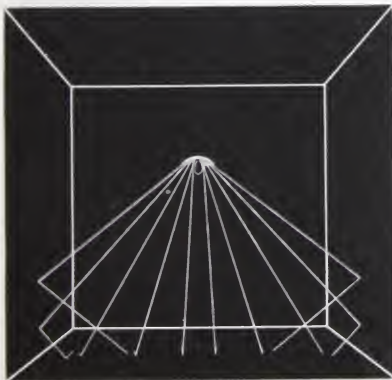
Laying aside what is good practice indoors, and considering the things that are most needed in illumination outdoors, there was nothing to do but give up the reflector idea and find something else that would be better.

A New Idea

In developing Holophane Refractors, the two principal limitations of modern street lighting have been escaped:

First, the impossibility of reducing the spacing between units, for sometime to come, at least; and

Second, the impracticability of making suitable reflectors or other apparatus for the greater extension and more efficient utilization of present illumination at existing spaces between units.



Typical action of reflector designed to throw light downwards and to eliminate waste above a horizontal line drawn through the center of the lamp. In a room where wide lateral extension of illumination is not necessary a reflector of this type is efficient.

Holophane Refractors

A Practical Solution

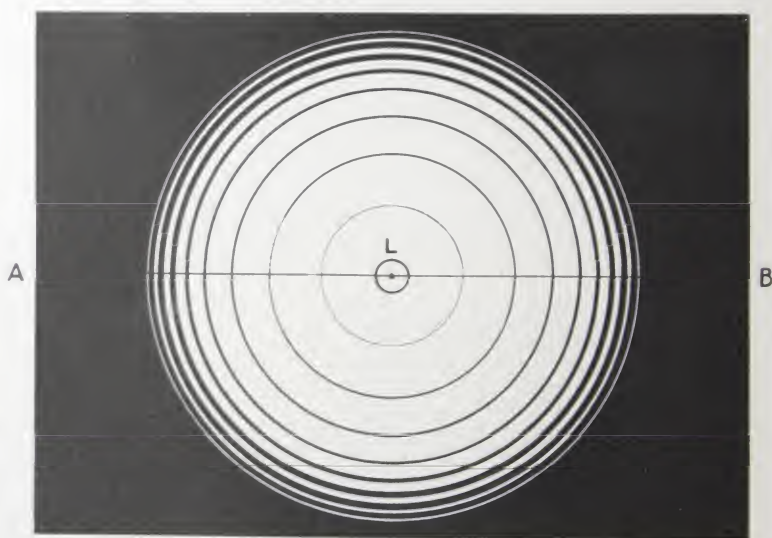
The Holophane Refractor provides a small and relatively inexpensive equipment that is so far superior to other auxiliaries for outdoor illumination that it serves in effect the same purpose as would be obtained by enlarging the capacity of existing units or reducing the spacing.

HOLOPHANE REFRACTORS

What They Are

Holophane Refractors are made of transparent glass with prismatic refracting surfaces designed on the lens principle.

Instead of being opaque, and bending the light back from a reflecting surface, with consequent absorption and other limitations, a Holophane Refractor allows the light to pass through its sides, and by the prismatic arrangement directs the illumination as desired.



The use of naked lamps for street illumination involves a waste of approximately 50 per cent of the light, or all that is emitted above the horizontal line AB drawn through the lamp centers. It also requires very close spacing in order to give adequate ground lighting without dark spaces.

Holophane Refractors

A Holophane Refractor consists of two clear glass bowls or bands, one of which fits snugly inside of the other. The joints are sealed to make a weatherproof union. The inner part is girdled on its outer surface by horizontal prisms which refract the light from the source at an angle of ten degrees below the horizontal. The outer part has vertical diffusing prisms on its inner surface for the purpose of spreading the light rays transversely and making the refractor luminous over its entire surface. The two prismatic surfaces come close together when the parts are sealed and the inner and outer surfaces of the complete refractor are entirely smooth.

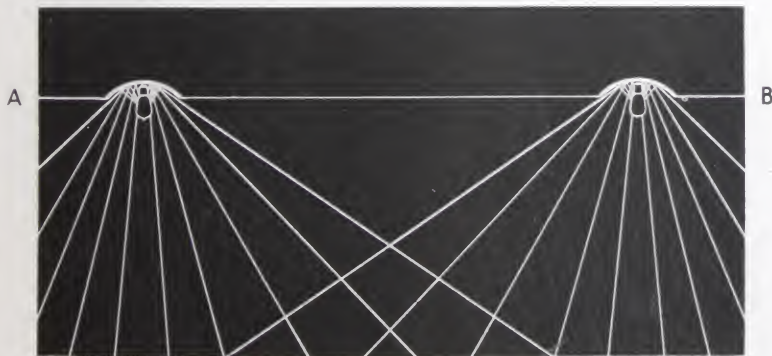
Construction

Holophane Refractors are made for service with arc lamps or Mazda C series street lamps. They are specifically designed and made for outdoor illumination.

Uses

They are available in two types, the bowl refractor, which is almost completely closed at the bottom, and the band refractor which, as its name indicates, is a refracting ring, almost cylindrical.

Types



Reflectors on street lamps prevent the waste above the horizontal line AB, but no reflector on the market gives sufficient lateral extension of light rays unless the lamps are spaced very closely.

Holophane Refractors

GENERAL ADVANTAGES OF HOLOPHANE REFRACTORS

Low Cost

Considered on the basis of efficiency and permanency, Holophane Refractors constitute a very inexpensive equipment.

No Weather Troubles

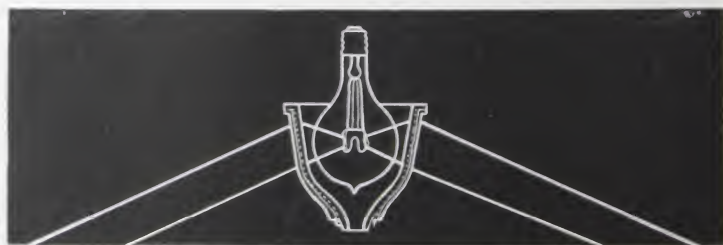
With perfectly smooth outer and inner surfaces, it is easy to keep a Holophane Refractor clean and free from dust and bugs. There is no shelf to collect snow and ice. Ventilation is good. Being small in size, the refractor has less chance of being maliciously or accidentally damaged.

HOLOPHANE BOWL REFRACTORS

Built on a Tested Principle

Prismatic, or refracting glassware has been in use for interior work for many years under the name Holophane.

Until recently one of the main objections to prismatic refractors for outside service was that the units could not be easily kept clean. This was because the refractors were made in a single piece which necessitated having the prismatic construction on the outside.



Typical action of Holophane Refractor, designed to give not only adequate downward illumination but also a lateral direction and extension of light that cannot be obtained from any reflector less than nine feet in diameter.

Holophane Refractors

By making the refractor in two parts, so that the prismatic surface can be sealed in the wall of the complete unit, the exposed surfaces are left quite smooth, and so may be as readily and quickly cleaned as a plain glass globe.

**Improvement
in Construc-
tion**

After an experience of several years, the breakage of Holophane Refractors is found to be very small. Of course a refractor costs more than a plain globe, but it is heavier and more stoutly constructed. It has a better form, and on the whole is less subject to accidental or malicious fracture.

**Minimum
Breakage**

The upper diagram on page 18 gives the photometric curve for a lamp stripped of all redirecting accessories. In the lower diagram the full line shows the results from the same lamp equipped with a Holophane Bowl Refractor.

Action

HOLOPHANE BAND REFRACTORS

The Holophane Band Refractor is a development of the standard bowl type, carried out along definite lines of requirement.

Construction

It is made in two parts, like the bowl refractor, and is simply the standard unit with the bottom removed.



Comparison of sizes Holophane Refractor shown by solid white line imaginary reflector shown by dotted line. Both designed to give maximum distribution at 65 degrees from a vertical line through the lamp. The Holophane Refractor is 8 inches in diameter, the reflector would have to be 9 feet in diameter.

Holophane Refractors

Object

It will be noted from the distribution curve on page 18 that there is a very low intensity immediately under a low candlepower lamp equipped with the bowl refractor. In fact the intensity at this point is materially less than it is with the bare lamp. This is because the bowl refractor redirects a large percentage of the upward and downward light to the 10 degree angle with the horizontal. In a low candlepower lamp this intensity cannot usually be spared directly beneath the source of light. The band refractor, by leaving the lower part of the lamp bare, permits its downward light to escape.

Effect

When lighted, the band refractor presents a beautiful, snappy appearance, and combines a wide-spread light distribution with excellent illumination beneath the lamp. With these merits it approaches the ideal for the class of illumination where incandescent brackets and center span fixtures are ordinarily used.

Holophane Refractor with reflector and fixture complete



Holophane Refractors



Bowl Type Holophane Refractor, made in two sizes, 6 and 8 inches in diameter.

Perfect ventilation of the lamp is assured because the lower part of the refractor is entirely open. **Ventilation**

For the same reason the accumulation of bugs and dirt is impossible. This insures uninterrupted freedom of downward lighting. **Bug Proof**

Cleaning is easy because the refractor is hinged and may be easily lowered. With liberal hand room the lamp and socket may be removed as a unit. **Liberal Hand Room**

The entire refracting unit is so small that it offers an inconspicuous mark for malicious damage. **Small Target**

The cost of the band refractor per unit is less than that of any other equipment. It permits the wide spacing of lamps. It is permanent. It gives a better and more beautiful distribution of light. It is free from physical limitations and defects. In maintenance it reduces expense to the minimum. **Low Installation and Maintenance Cost**

Holophane Refractors



Small Holophane Bowl Refractor made for 100 watt multiple Mazda C lamps. Diameter 6 inches. The fixture is a copper unit and includes lamp receptacle. It is tapped for $\frac{1}{2}$ inch pipe bracket. This unit is highly efficient for the illumination of store fronts, shipping and baggage platforms, railway stations and arcaways. It provides for wide distribution of light with few units.

Holophane Refractors



Holophane Band Refractor, large size, diameter 8 inches. For use with 250, 400, 600 and 1000 c.p. Mazda C series lamps.

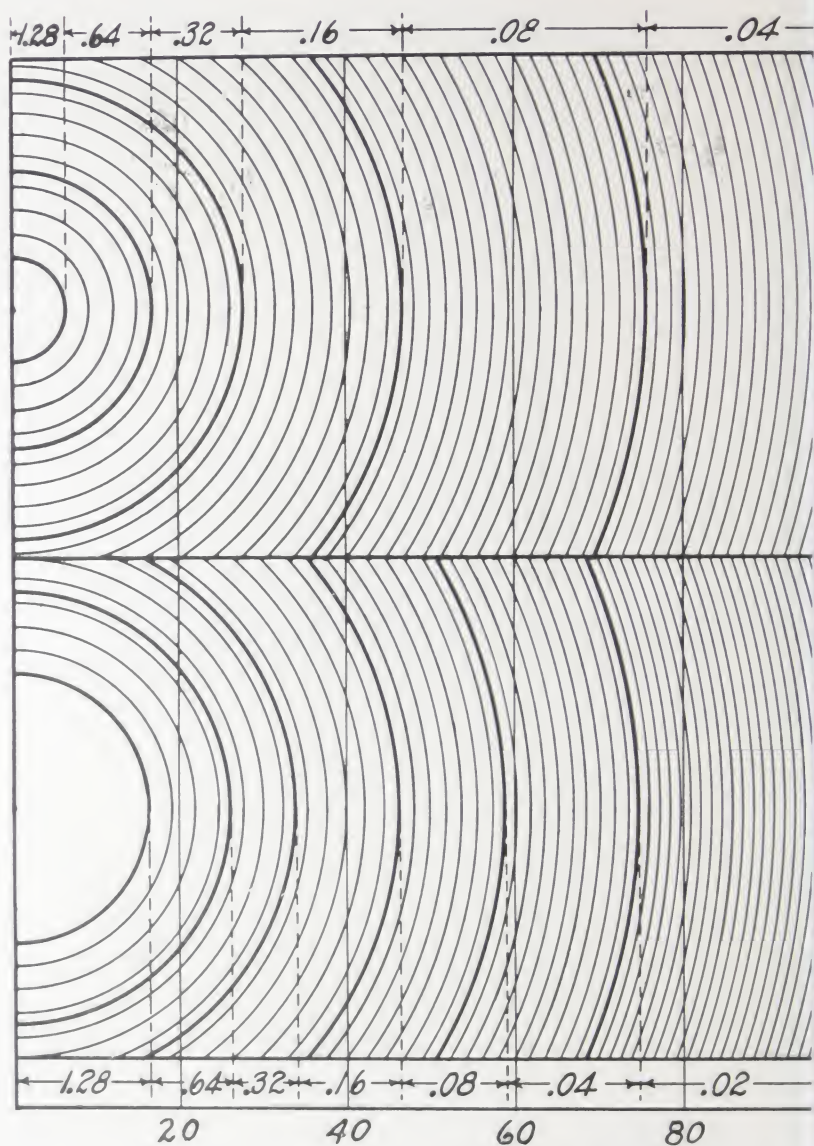


Holophane Band Refractor, small size, diameter 6 inches. For use with 60, 80 and 100 c.p. Mazda C series lamps.



Complete Holophane Refractor unit, showing fixture and side bracket.

Holophane Refractors

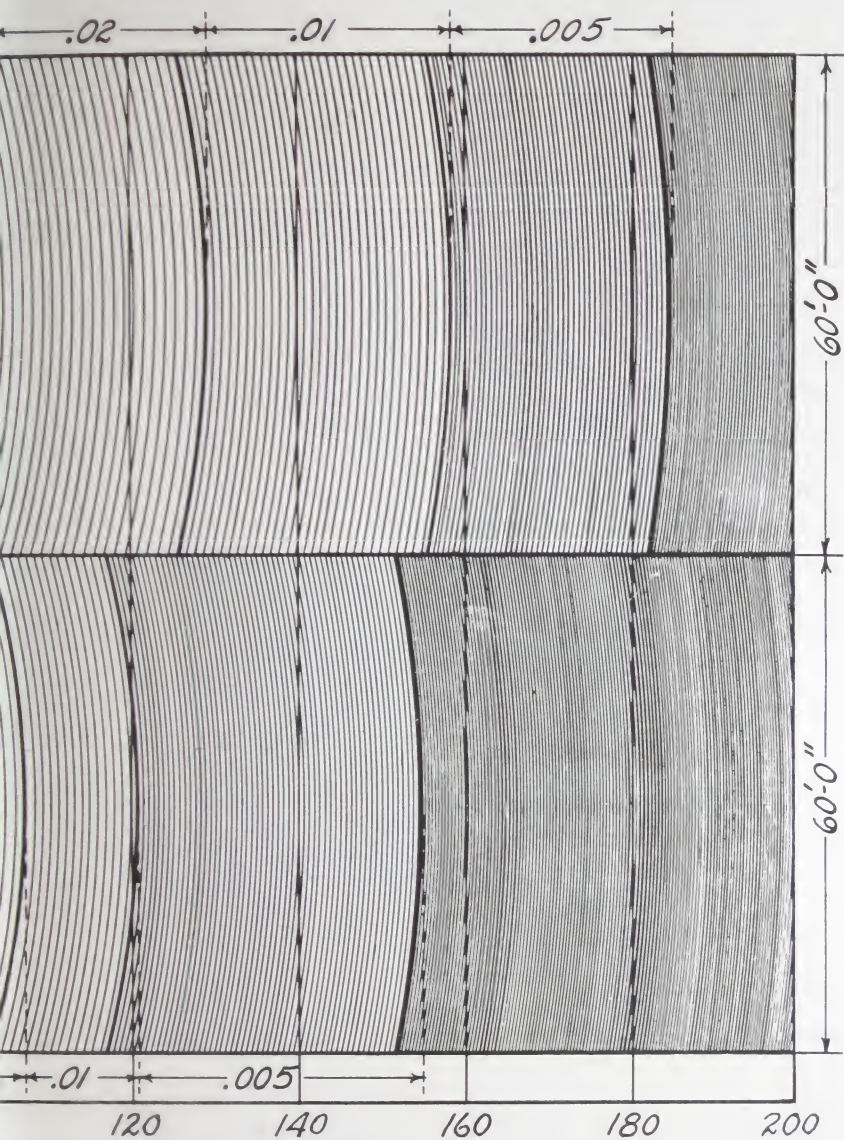


COMPARISON OF

This diagram represents the light distribution from a 1000 c.p. lamp suspended 20 feet above the ground.

The upper half gives the result from a Holophane Band Refractor and the lower half from a porcelain reflector and clear globe. In each case

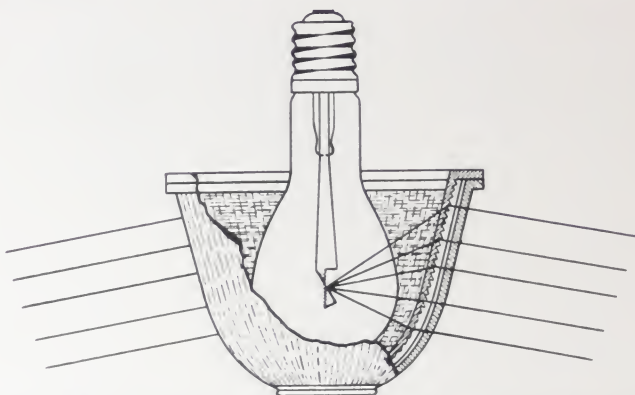
Holophane Refractors



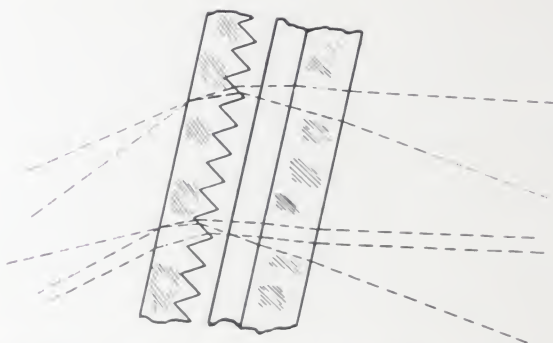
LIGHT DISTRIBUTION

The area represented is a street 60 feet wide and 200 feet out from the lamp. Decimal figures immediately above and below the shaded portions represent actual foot-candles delivered. Notice not only the greater evenness of distribution but the greater extent with the Holophane Refractor.

Holophane Refractors

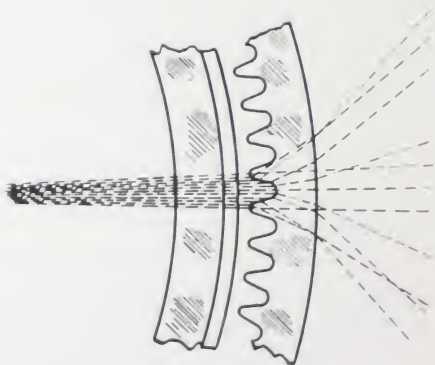


Sectional view of Holophane Bowl Refractor, showing relation of horizontal and vertical prisms, and resulting wide distribution of light



Enlarged section on a vertical plane showing action of inner or horizontal prisms, in extending the light rays

Enlarged section on a horizontal plane, showing action of outer, or vertical prisms, in diffusing light.



Holophane Refractors



Approximation of result obtained by Holophane Refractor through the substitution of a double reflector.



Substitution of a triple reflector with greater lateral distribution, but not so good as with a Holophane Refractor. More expensive and complicated.



Imaginary reflector designed to give same lateral extension and distribution as an 8 inch Holophane Band Refractor. This reflector would have to be 16 feet in diameter, and is obviously impracticable.

TECHNICAL SERVICE

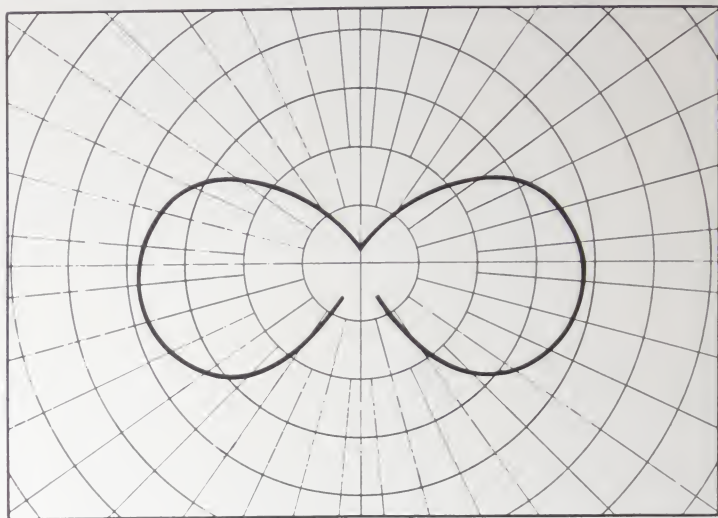
We are prepared to furnish complete specifications for the proper illumination of streets.

This service is available not only on new installations, but also in connection with the conversion of existing installations to a more efficient basis.

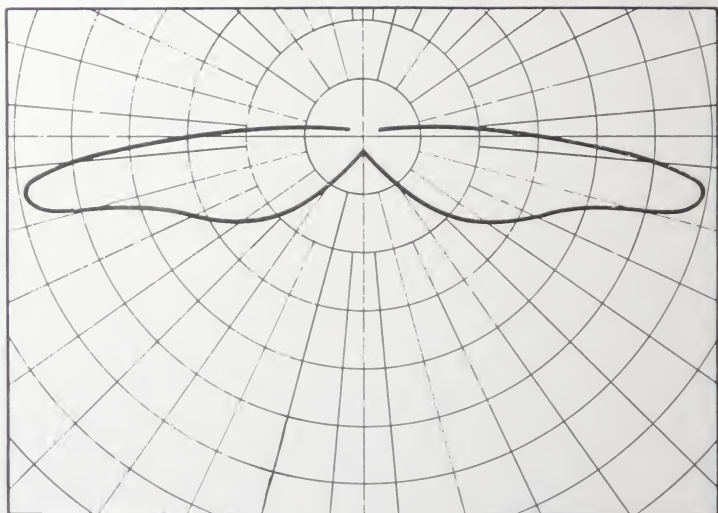
The making of definite plans involves the study of the actual conditions, whether urban or suburban, business or residence sections.

The plans include recommendations on the type of lamp; form of suspension; height from the ground; spacing between units; candlepower of unit; size and kind of refractor, and other essential elements for economical and effective illumination.

Holophane Refractors



Photometric curve showing normal bare lamp distribution



Photometric curve showing much wider extension of light from same lamp with Holophane Bowl Refractor

Holophane Refractors



Form 17 Direct
Current Series
Luminous Arc
Lamp, 4 Amperes,
with Retractor

Holophane Refractors



Daylight view of Superior Avenue, Cleveland, Ohio. Closed or Bowl type Holophane Refractors with 400 c.p. Mazda C series street lamps.



Night view of same installation. Even with widely spaced units the light distribution is very satisfactory.

Holophane Refractors



Part of installation at Bellefonte, Pa. Novalux units equipped with Bowl type Holophane Refractor.

Holophane Refractors



San Diego, Cal. Holophane Bowl Refractors with 600 c.p. 20 ampere Mazda C series lamps. Height averages 26 feet



San Diego, Cal. Same installation in service, from same viewpoint as above. Spacing varies from 300 feet in center of city to 1000 feet in outskirts.

Holophane Refractors



San Diego, Cal. Notice the band effect extending from a point on the ground beyond the lamp, up to the camera.



San Diego, Cal. Center lamps pendant on suspension wires, 600 c.p. Mazda C series lamps with Holophane Refractors. Ornamental units are 100 watt multiple lamps.

Holophane Refractors



Long Beach, N. Y. 400 c.p., 15 ampere Mazda C series lamps with Holophane Refractors, 400 foot spacing, 17 feet high.



Bellefonte, Pa. 400 c.p., 15 ampere Mazda C series lamps with Holophane Refractors.

Holophane Refractors



San Diego, Cal. Holophane Refractor units in residence section.



Broadway, Long Beach N. Y. New installation providing for additional units later. 400 foot spacing, 17 feet high, 400 c p. 15 ampere Mazda C series lamps with Holophane Refractors.

Holophane Refractors



Shaker Boulevard, Cleveland, O. Wide spacing, but efficient illumination as indicated below



Shaker Boulevard, Cleveland, O. A good basis for additional units as the section builds up

Holophane Refractors



Last 74th St., Cleveland, O. Holophane Band Refractors. Notice apparent wide spacing and study illumination results shown below.



Last 74th St., Cleveland, O. Excellent four-way corner lighting and extension between units.

Holophane Refractors



Shaker Heights,
Cleveland, Ohio
Lamps 20 feet high
on six foot side
brackets, 450 foot
spacing

A satisfactory installation
of Holophane Bowl
Refractors and Mazda
C series lamps. More
units to be added later.



Holophane Refractors

INSTALLATIONS OF HOLOPHANE REFRACTORS

California	San Diego	650	units
Georgia	Mason	30	"
Illinois	Marion	96	"
	Danville	24	"
Indiana	Evansville	500	"
	Plainfield	27	"
	Danville	38	"
Iowa	Clinton	40	"
Kansas	Parsons	120	"
Michigan	Iron River	92	"
	Escanaba	135	"
	Grand Rapids	25	"
	Adrian	145	"
	Saginaw	530	"
	Negaunee	49	"
Minnesota	Staples	8	"
	Lake City	30	"
Missouri	Nevada	92	"
New York	Long Beach, L. I.	28	"
	Dunkirk	300	"
	Jamestown	14	"
New Jersey	Pitman	20	"
No. Carolina	Albemarle	57	"
Ohio	Cleveland	600	"
	Findlay	55	"
	Middletown	392	"
Pennsylvania	Carlisle	108	"
	Lewistown	38	"
	Mahanoy City	190	"
	Miners Mills	36	"
	Sellersville	90	"
	St. Clair	30	"
	Shenandoah	65	"
	Wilkesbarre	28	"
Texas	Brenham	12	"
W. Virginia	Charleston	260	"
Wisconsin	Eau Claire	360	"
Brazil	Bahia	550	"

(This list is not complete)







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CCA